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A simple liquid flow recorder

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A liquid flow recorder of simple design which can be easily constructed with readily obtainable material at low cost is described. It is used with a piston recorder and a time interval marking clock to measure the rate of liquid flow over a range of a few drops to 50 ml/min.

THERE are several types of liquid flow recorders used in physiological laboratories: that described by Haranath (1962); Stephenson's flow recorder (Burn, 1952); Gaddum's drop recorder (1953); Thorp's impulse counter (1953); Rothlin's drop counter (1960); Fleisch's (1960) totalisator; a simplified recording bubble flow meter for measuring blood flow by Hammond, Hyman & Nelson (1950) and a volume recorder devised by Bülbring, Crema & Saxby (1958).

The shortcomings of these recorders are: (i) the simple types of Haranath, Stephenson and Gaddum lack range and therefore can be used to measure only a slow rate of flow; (ii) excepting the recorders of Hammond and Bülbring, all the others do not furnish quantitative data of the rate of flow and (iii) the advanced types are elaborate in design and expensive to construct. We present here a simple recorder which can be constructed with ordinary material and parts at low cost.

DESIGN AND SPECIFICATION

The present liquid flow recorder consists of three units: (1) a piston recorder (Palmer B126); (2) an A.C. time interval marking clock (Palmer C50) and (3) a glass vessel with accessories mounted on a wooden block. The whole assembly of the recorder in use is shown in Fig. 1. Items 1 and 2 are standard equipment usually available. The third item can be constructed from the parts as shown in Fig. 2. "A" is a glass vessel constructed with a side tube near its upper end for connection to a piston recorder; "B" is a glass funnel about 3 in in diameter for the collection of liquid inflow. This is fixed to the upper opening of glass vessel "A" (see Fig. 1). The stem of the funnel is about 5 cm long and its lower opening is constricted to about 1 mm in internal diameter to convert the lower opening into an inlet liquid valve. This constriction allows the liquid flowing through it by means of capillary action, to effect a "liquid seal". This enables the piston recorder to respond to the changes in pressure within the glass vessel "A" after liquid has entered it. "C" is soft rubber tubing, about 5 cm long and 5 mm in diameter, attached to the lower end of glass vessel "A". The type used in reservoirs in fountain pens was most suitable. "D" is a lever made of perspex, one end of which is bent into a hook. This has a hole of 5 mm in diameter drilled through it at the position shown, to allow passage of the soft rubber tubing (see Fig. 2). At the other end of the lever is mounted a nut "N"

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of about 20 g weight. The function of the lever is to close the soft rubber tubing with the hook end by the weight of the nut, thus preventing the liquid in the glass vessel "A" from flowing out. "S" is a solenoid of 500 ohms resistance, which, when magnetised by a momentary flow of

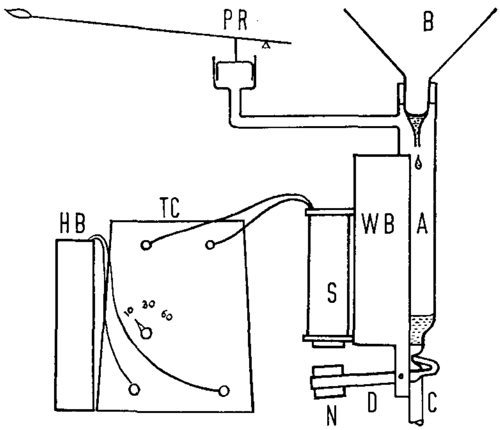

FIG. 1. Assembly of the liquid flow recorder composing of the following parts: A, glass vessel; B, a glass funnel; C, rubber tubing; D, perspex lever; HB, high tension battery; PR, piston recorder; S, solenoid; TC, time clock; WB, wooden block, and N, bolt nut.

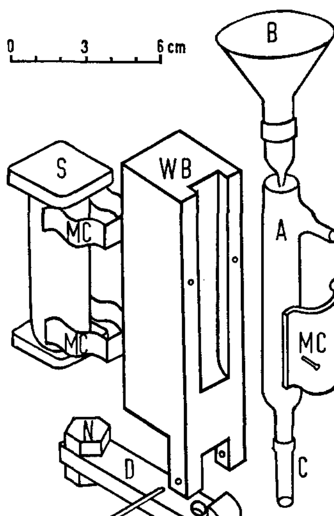

FIG. 2. Breakdown parts of the liquid flow recorder; A, glass vessel; B, a glass funnel; C, rubber tubing; D, perspex lever; N, bolt nut; MC, mounting clip; S, solenoid and WB, wooden block.

current produced by the time clock closing the circuit, raises the nut "N" allowing the Perspex hook to move downward thus relieving the pressure on the rubber tubing. The liquid collected in the glass vessel "A" then flows out. "WB" is a wooden block for the mounting of "A", "S" and "D" together. "MC" are three metal clips. A breakdown of the design of the recorder into its various parts is shown in Fig. 2.

OPERATION

Before the recorder is used, a piston recorder of suitable size is chosen and connected to the side tube of glass vessel "A" by rubber tubing. A 45 V dry battery is connected to the solenoid through the signal posts of a time clock. The time interval for the time clock to operate the solenoid circuit is selected on the basis of the slower the rate of liquid flow to be measured, the longer the time interval.

The liquid is collected by funnel "B". On entering glass vessel "A", it raises the air pressure therein and causes the writing lever of the piston recorder to rise. The rise in height of the lever is proportional to the volume of liquid entering the vessel "A". The height recorded by the lever per unit time is thus a direct measure of the rate of liquid flow. A calibration scale of the height in terms of the rate of flow in volume/min should be made before the operation of the recorder. An example is shown on the left-hand side of Fig. 3 which is a tracing showing changes in the rate of outflow of perfusate coming out from the blood vessel of

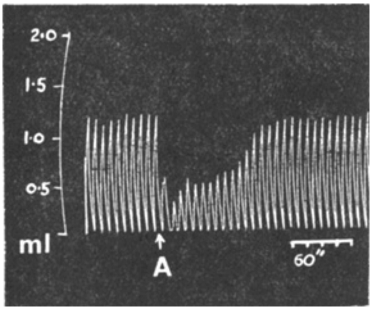

FIG. 3. Kymograph tracing showing changes in the rate of liquid-flow through the blood vessels of a perfused isolated rabbit ear as affected by the injection of 0·25 μg of adrenaline at A to the perfusate made with the present recorder. A calibrated scale of the rate of flow per 30 sec is shown on the left-hand side. Time is in 60 sec.

an isolated rabbit ear as affected by the injection of 0·25 μg of adrenaline. The downward stroke of each tracing registers the draining out of the collected liquid from glass vessel "A" at an interval set by the time clock and performed by the action of the solenoid "S".

DISCUSSION

We find the present flow recorder offers the following advantages: (1) the main unit can be easily constructed from readily obtainable materials at low cost; (2) the tracing obtained shows at a glance, changes in a positive way the rate of liquid flow and also gives a quantitative measure when referred to the calibration scale; (3) it offers a fairly high sensitivity of response which is reproducible and (4) by varying the glass vessel "A", and the piston recorder size and the time clock setting, the range of the recorder can be extended from a few drops to 50 ml/min.

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